research management
findings
Number 21 • March 1989

EXPERIMENTAL NORTHERN RED OAK REGENERATION IN NORTHEAST WISCONSIN

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Oak forest dominated by northern red oak (Quercus rubra) is an important habitat for many wildlife species in northeast Wisconsin including deer, squirrels, raccoon, black bear, ruffed grouse, woodpeckers, bluejays, and various other songbirds. Effective techniques have not been developed to regenerate oaks in the Lake States, especially on mesic sites (Lorimer 1985). Future losses and reduction in oak forests in Wisconsin and other areas of the U.S. concern both wildlife biologists and foresters.

In 1987 I studied the effects of experimental silvicultural treatment on red oak stands in the Navarino Wildlife Area in northeast Wisconsin. The treatment included a shelterwood cut to 70% crown density and a spring burn. Because fire has been suggested as important to oak regeneration (Curtis 1959, Lorimer 1985, Crow 1988), I felt that burning might be useful in aiding oak seedling establishment and release from competing plants. My objectives were to determine the effects of: (1) shelterwood cutting on oak seedling numbers, (2) burning on oak seedling numbers in both shelterwood cut and uncut oak stands, and (3) shelterwood cutting and burning on understory vegetation and possible impacts on wildlife habitat. In this issue of "Findings" I am reporting on seedling growth within the shelterwood cut, and the response of oak seedlings to fire.

Earlier Work at the Navarino Wildlife Area

In experimental trials of oak regeneration at the Navarino Wildlife Area, Sloan and Zastrow (1985) found that clearcuts were not effective for oak regeneration and that thinning to various basal area levels did not produce conclusive results. These researchers found that crown density (canopy coverage of overstory vegetation) correlated more highly with oak seedling numbers than did basal area measurements.

Consequently, Sloan and Zastrow developed an experimental shelterwood cut for a 25-ha northern red oak stand. Through a commercial timber sale they reduced the crown density to 70% in spring 1984. Some of the competing small trees were removed by a Wisconsin Conservation Corps crew. My study was conducted on the same 25-ha stand, plus a nearby uncut stand.

Study Area

The Navarino Wildlife Area is located in Shawano County on the northern edge of the tension zone--the narrow zone that divides the prairie forest province of southern Wisconsin from the northern hardwood province of northern Wisconsin (Curtis 1959). Major vegetation in the wildlife area includes sedge meadows, shrub swamp, aspen, bottomland hardwoods, swamp hardwoods, white and red pine, white cedar, oak, northern hardwoods, and upland grass. About 60% of the 6,000-ha wildlife area is wetlands and about 50% is forest. Oaks cover about 342 ha of the wildlife area.

Methods

Initial and post-harvest measurements of crown density were made using a grid densimeter (Sloan and Zastrow 1985). The timber sales and post-sale cuttings reduced the canopy from 95% to 69.6%.

Prescribed burns were conducted on 6 ha of the shelterwood stand and on 2 ha of a 12-ha uncut oak stand on 5 May 1987. The uncut oak stand was similar in crown density and composition to the shelterwood stand before the timber harvest.

The uncut oak stand was burned between 11:20 a.m.-12:30 p.m. with temperatures at 18-20 C, winds W-NW 3-8 km/hr, relative humidity 31-32%, and flame heights of 0.3-0.6 m. The shelterwood stand was burned between 1:15 p.m.-2:30 p.m. with temperatures at 20-22 C, winds N 3-8 km/hr, relative humidity 29-31%, and flame heights of 0.5 -6 m.

Oak seedlings were counted in mid-October using circular 16 m^2 plots; 30 plots were used on each uncut stand, 48 on the shelterwood control stand, and 32 on the shelterwood burn stand.

Understory vegetation was analyzed in 15 1-m^2 quadrants in each of the 4 treatment areas (uncut control, uncut burn, shelterwood control, and shelterwood burn) in August 1987. Canopy coverage was estimated for all understory plants.

The student's *t*-tests were used for determining differences in oak seedling counts per stand.

Results and Discussion

Oak seedling counts

Total oak seedlings per hectare increased from 1,418 in 1984 (the year of the shelterwood cut) to 5,235 in 1985. Large seedlings (>1.4 m) increased from 0/ha in 1984 to 93/ha in 1987. Seedling counts consisted of both red and white oak, although red oak seedlings were more abundant. Advanced regeneration of oaks is considered adequate when 1,075 trees >1.4 m height/ha are present (Sander et al. 1983). Obviously the shelterwood stand is still far from this level.

Oak seedling counts in shelterwood stands were much higher than seedling counts in the uncut oak stands (Table 1). The total oak seedling count in the unburned portion of the uncut stand (1,504/ha) was similar to that in the shelterwood stand before cutting; therefore, I felt that the unburned portion of the uncut oak stand was a suitable control. There were more oak seedlings in burned than unburned stands, except in the tall size class (>1.4 m). The lack of taller seedlings in the burned stands was probably due to mortality from the fire. The single growing season following the burn was not enough time for re-sprouting oaks to reach the 1.4 m height.

The number of oak seedlings on the uncut control stand was very different ($P < 0.001$) from that on the shelterwood control stand. The number of oak seedlings was not significantly different ($P > 0.10$) between the burned and control portions of the shelterwood and uncut stands. Apparently, tree canopy closure had more impact on oak seedling abundance than did the spring burn.

Effects on understory plants

Both burning and timber cutting caused substantial changes in the understory of the four oak stands (Table 2). Witch hazel was reduced in both shelterwood and uncut oak stands, while red maple seemed to be reduced only in the shelterwood stand.

Woody plant coverage slightly increased in the shelterwood stand, probably due to the invasion of staghorn sumac after the spring burn. Although not specifically measured, the stature of woody plants on the burned shelterwood stand was greatly reduced. Overall plant coverage, especially forbs, seemed to be reduced by fire in the burned uncut oak stand. Overall plant coverage in the burned shelterwood stand remained similar to the unburned shelterwood stand. The total number of understory species was similar among the stands.

Table 1. Oak seedling counts (no./ha) on oak stands at the Navarino Wildlife Area in 1987.

	Uncut Oak		Shelterwood	
Height	Control	Spring Burn	Control	Spring Burn
<0.3 m	1,462	1,648	2,575	2,923
0.3-1.4 m	42	208	1,468	2,471
>1.4 m	0	0	146	20

Table 2. Major understory plants and mean canopy coverage (%) among four oak stands at the Navarino Wildlife Area.

	Uncut Oak		Shelterwood	
Plant Species	Control	Spring Burn	Control	Spring Burn
Red maple	1	3	10	2
Witch hazel	8	4	7	4
N. red oak	1	1	2	3
Staghorn sumac	0	0	0	12
Raspberries	2	2	38	42
Canada mayflower	4	2	<1	<1
Star-flower	2	1	1	0
Pennsylvania sedge	2	1	24	15

Effects on large trees

Few large trees (10 cm diameter) were killed on the burned uncut oak stand, but I did see several dead trees on the burned shelterwood stand. Mortality seemed to be higher for species other than oak, such as paper birch and white pine. These dead trees will probably provide snags for wildlife use.

Wildlife use

I did not specifically measure wildlife use, but I did observe many signs of deer browsing on the burned shelterwood stand. The invasion of staghorn sumac and the sprouting of other woody plants provided abundant high quality forage. I saw few tree squirrels but many chipmunks on the oak stands.

Conclusions and Recommendations

Reduction of an oak forest canopy to 70% crown density drastically increased the abundance of oak seedlings in the understory. Spring burns in an uncut oak stand (>95% crown density) did not seem to increase the abundance of oak seedlings after one growing season. Burning did appear to decrease the abundance of red maple seedlings on the shelterwood stands, but did not affect red maple abundance on the uncut oak stand. Large slash piles and drier conditions due to the more open canopy caused the shelterwood stand to burn hotter and perhaps caused higher mortality to red maple seedlings. The reduction in seedlings of red maple, a major competitor of oaks, is beneficial in oak regeneration. Other woody plants, such as witch hazel, also were reduced by fire but some shrubs, such as sumac,

invaded only after the burn. Raspberries, although reduced in overall height, were otherwise unaffected by burning.

For wildlife management, burning after the shelterwood cut had some benefits. Because of the intensity of the fire, several large trees such as paper birch and white pine were killed, providing snags for wildlife use. Deer benefitted from the improved forage available after the burn, due to sumac invasion and sprouting of other woody plants.

The final cut of the shelterwood stand should occur once the oak seedling count reaches 1,075 well-spaced seedlings (>1.4 m high) per hectare. The silvicultural recommendation is to remove the remaining mature trees to release the seedling oaks (Sander et al. 1983). Because this technique eliminates the mast crops for many years, this prescription should be modified for a wildlife area to leave a residual canopy of about 30% mature oaks.

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